# Technical Training for PG&E's Intermittent Renewable Resources and OpenADR Integration Pilot

## February 8th 2011

# Agenda

- 9:00 - 9:30 am  Coffee and pastries

- 9:30 – 10:00 am Introduction to the project (John Hernandez, PG&E)

- 10:00 – 11:00 am Communication Infrastructure (Ed Koch, Akuacom/Honeywell)

- 11:00 – noon Demand Response Strategies and Process (Sila Kiliccote, LBNL)

# PG&E's
# 2011 Intermittent Renewable Resource Pilot

# Overview

- **Regulatory Context**

- **Characteristics of Intermittency**

- **Pilot Objective - Characteristics**

- **Next Steps**

# Regulatory Context

| | |
|---|---|
| September 2002 | State of California introduced a bill that requires all California Investor Owned Utilities (IOU), Energy Service Providers (ESP), and Community Choice Aggregation (CCA) to add at least 1% of renewable each year and have an ultimate target of 20% by 2010 |
| November 2008 | State of California mandated a RPS target of 33% by 2020 |
| August 2009 | California Public Utilities Commission (CPUC) approves pilot demonstration through D.09-08-027 (2009-2011 Demand Response Cycle) |

# Intermittent Renewable Resource

What is an intermittent resources?

How volatile are these resources?

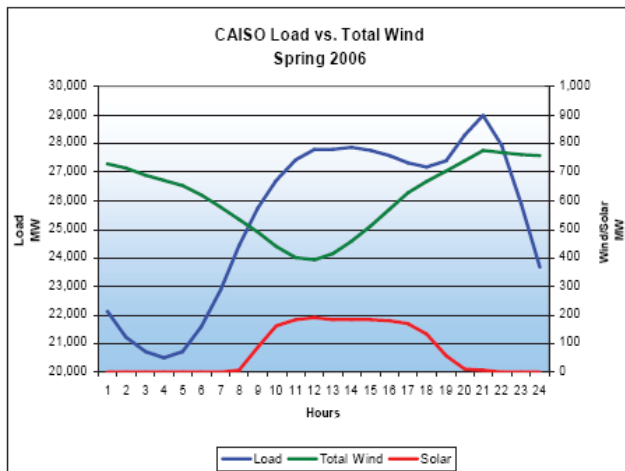# Wind's Seasonal Variability



Figure 5-4: Actual System Load, Wind Generation and Solar Generation for Spring
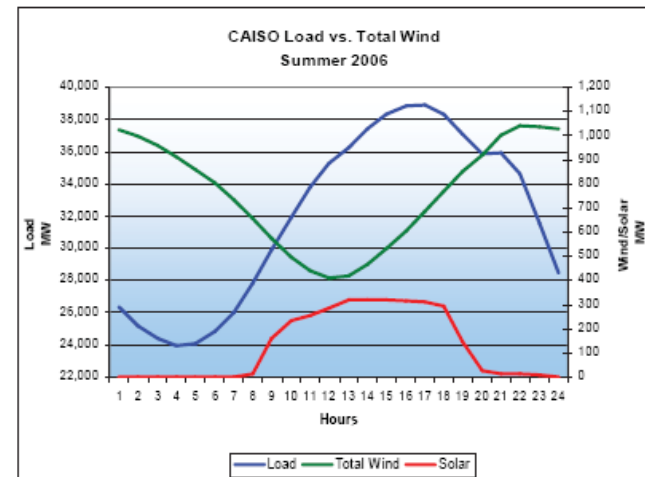


Figure 5-7: Actual System Load, Wind Generation and Solar Generation for Summer 2006
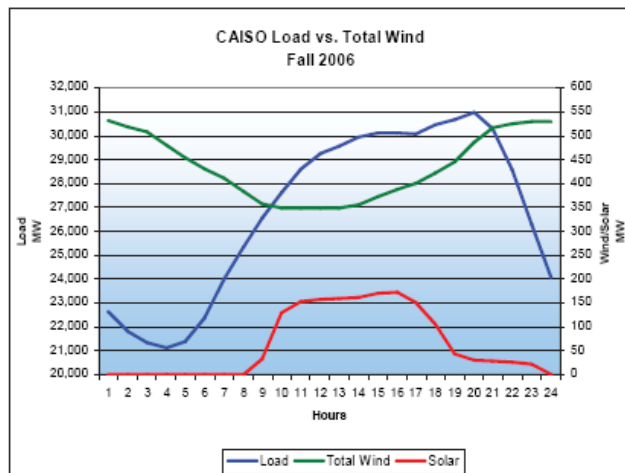


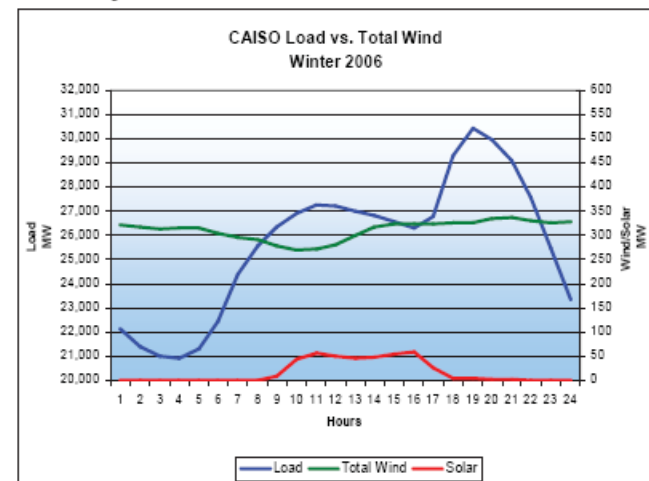Figure 5-9: Actual System Load, Wind Generation and Solar Generation for Fall 2006
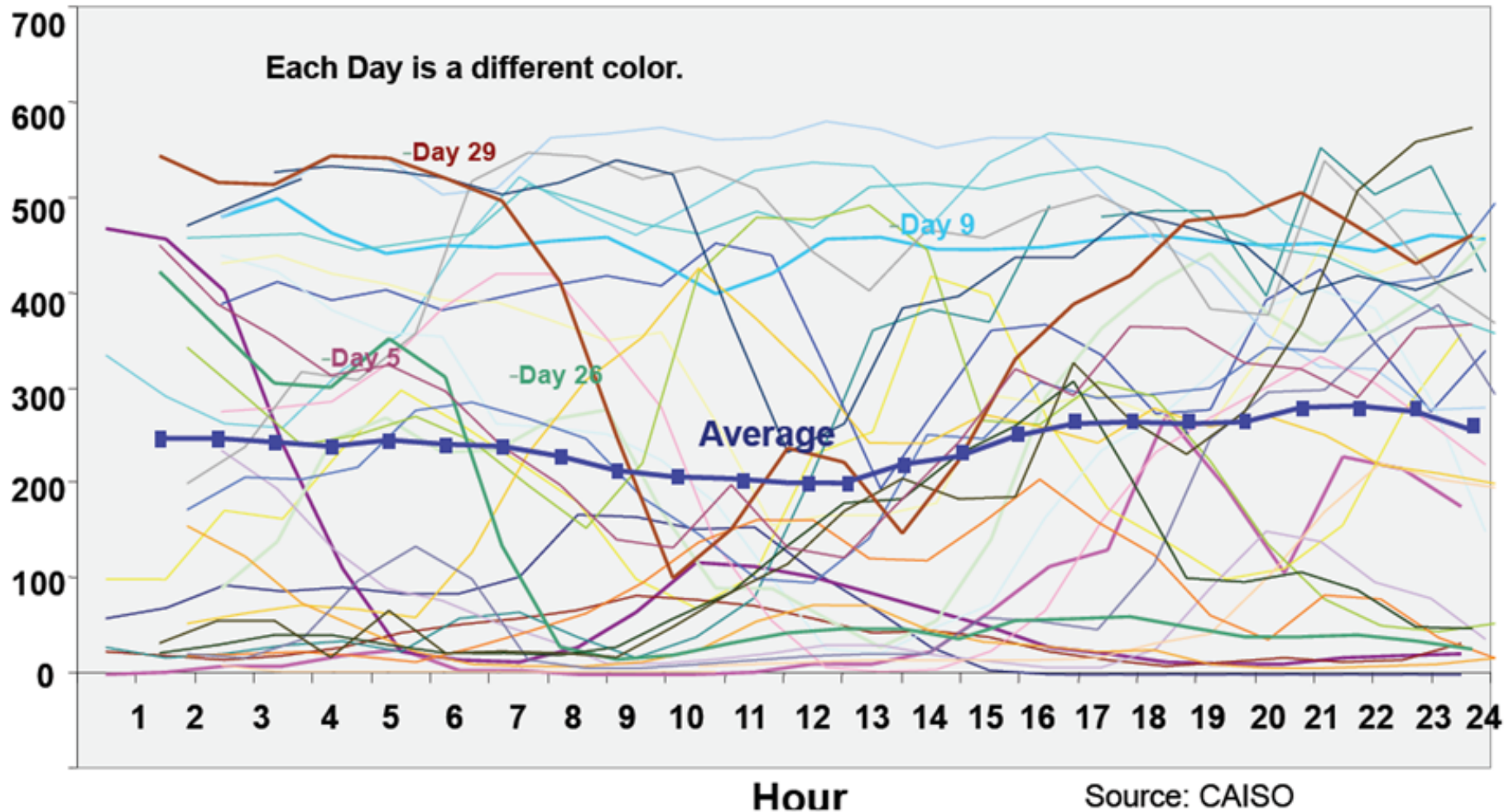


Figure 5-11: Actual System Load, Wind Generation and Solar Generation for Winter 2006

Source: CAISO, Integration of Renewable Resources, 2007

# Wind's Day-to-Day Variability



MW

Each Day is a different color.

Day 29

Day 5

Day 26

Day 9

Average

Hour

Source: CAISO

# Solar Variability



PV Output — 3/25/2008
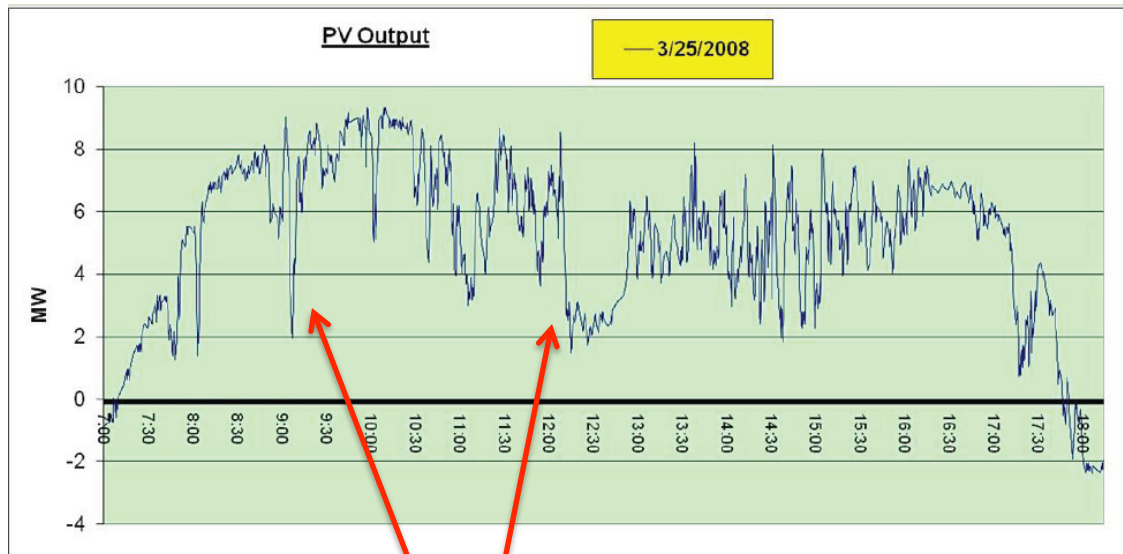
While solar has more day-to-day predictability than wind, large ramps can cause major operating issues

**Concentrating solar 4-21-09**



Ramps (both down and up) over 50% capacity in under 20 minutes

Source: CAISO IRRP Stakeholder Meeting on Renewable Integration Requirements, 10/20/09

# Solar Forecast Error
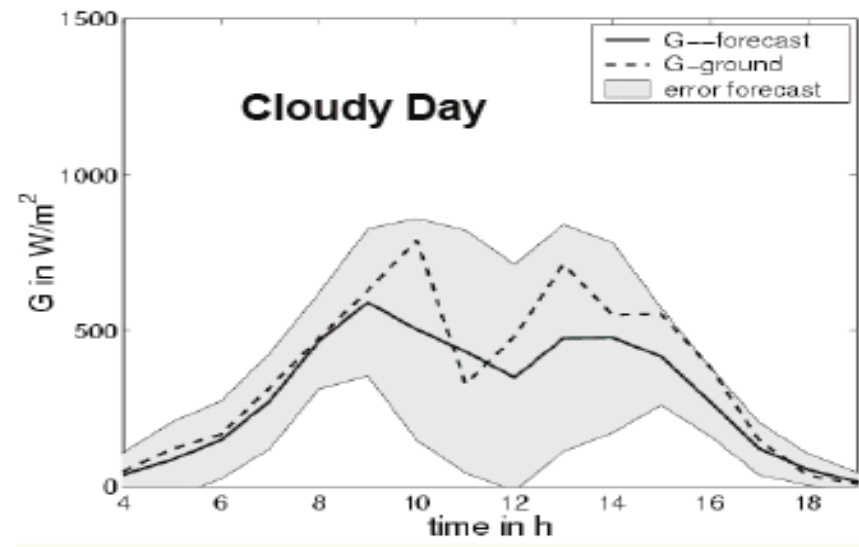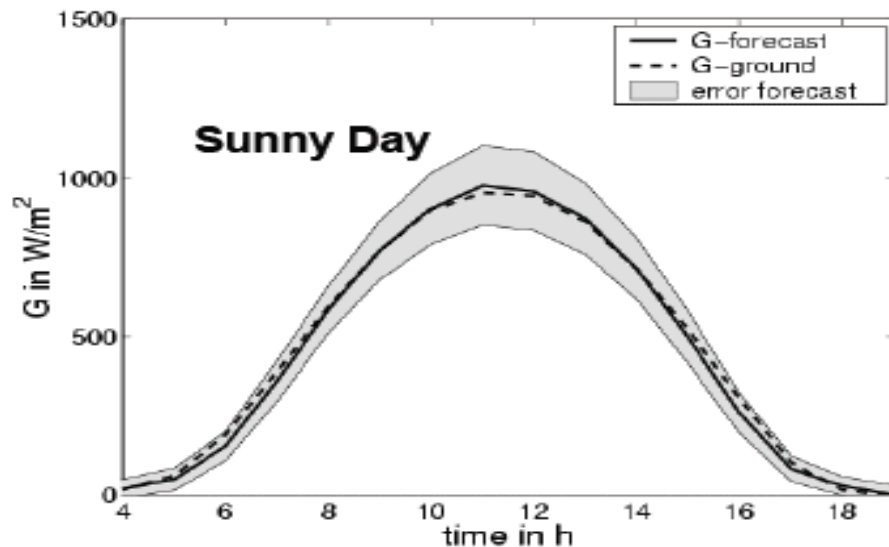


**Solar forecast error increases significantly for cloudy days**

10

# When Combined



Daily peak management

Ramp Smoothing

Load Shifting & Ancillary Services
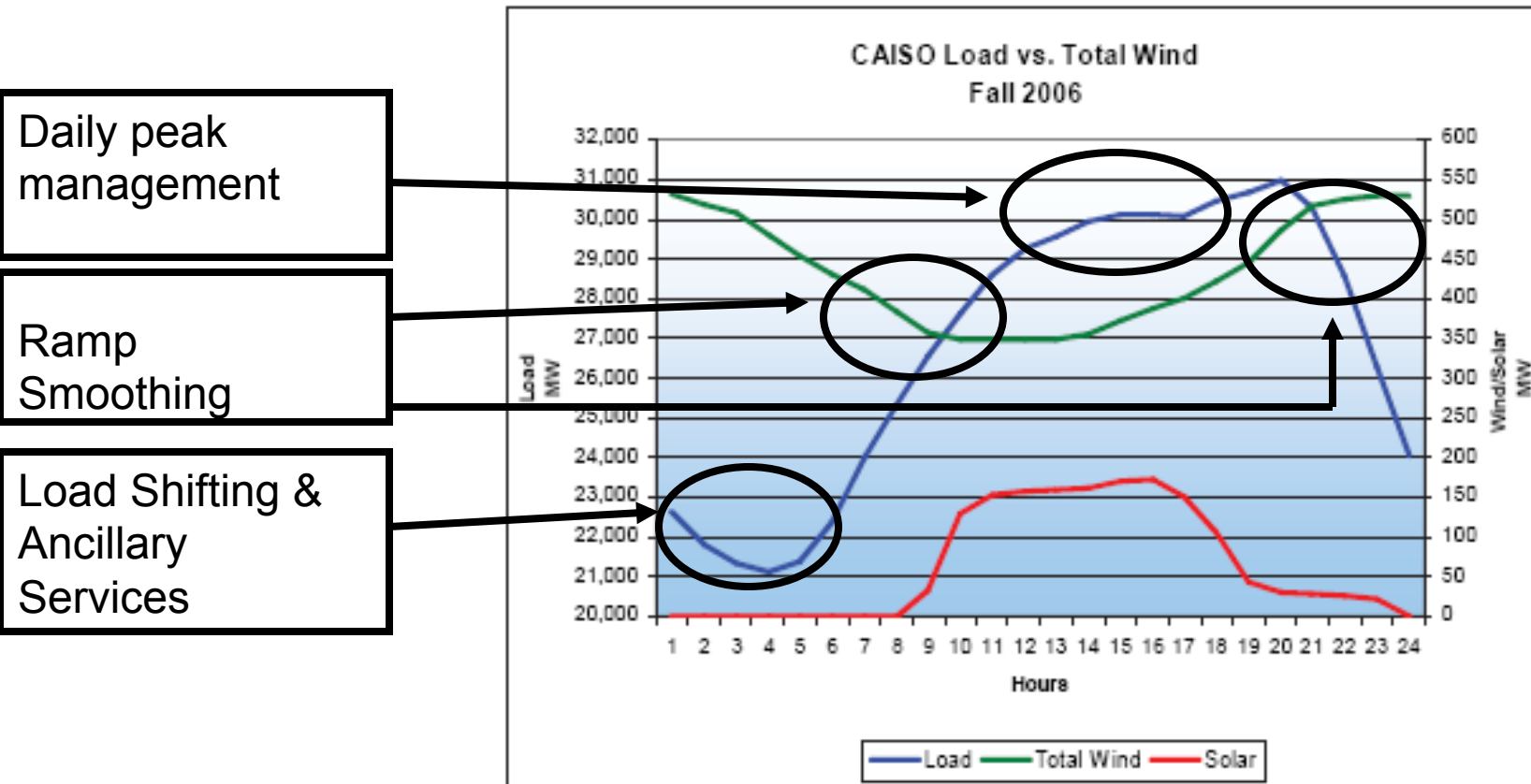
Figure 5-9: Actual System Load, Wind Generation and Solar Generation for Fall 2006

# Intermittent Renewable Resource
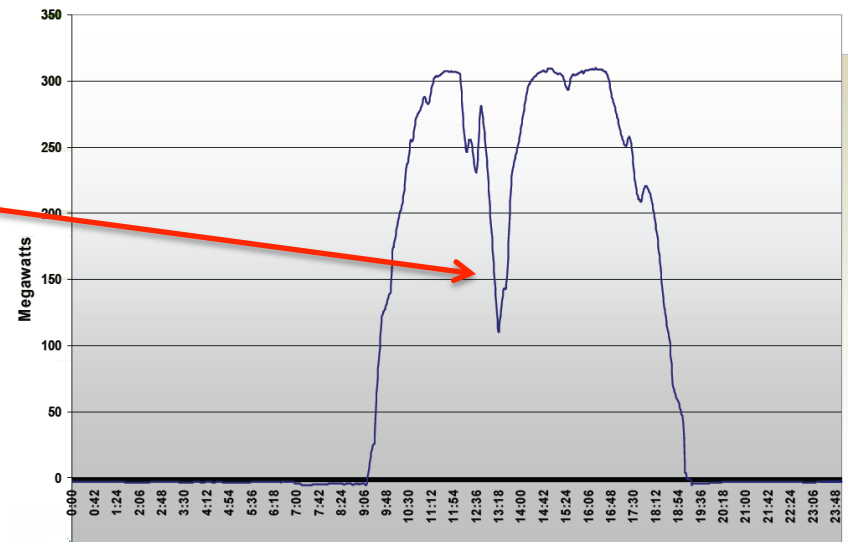
Can PG&E enable demand response participants to help mitigate the negative affects of intermittent resources?

If so, what is needed?

# End Use Resources

- Based on the nature of the Pilot the following identified end-uses will be needed for this study:
    - Ventilation
    - Air conditioning
    - Thermal energy storage
    - Industrial refrigeration
    - Lighting
    - Wastewater treatment
    - Water pumping/supply
    - Year-round/seasonal product manufacturing

# Pilot Enablement

- Pilot will equip the customers with the following:
    - Auto-DR communication and technology
    - Real time telemetry
- Availability:
    - May 2011 – October 2011
    - Monday – Sunday
    - 24 - 7

# **Pilot Characteristics**

- Pilot will need these customers to curtail or consume within:
  - Seconds
  - Less than 5 minutes
- Duration:
  - Min of 2 hours
- Events:
  - Max of 5 calls

# Pilot Enrollment

- Site visits
- Signing a Memorandum of Understanding (MOU)
- Enablement
- Field Test – Site feedback
- Analysis and Results

# Incentives

- Participation incentives: Customers earn $1000 (per month) for operational activities (during scheduled operations timeline) outside their normal day to day activity.

- Performance Energy Incentives: For any dispatch instructions made by CAISO or PG&E (test or event), resources are paid CAISO's Local Marginal Price for energy.

- Time-of-use Rate Differential Incentive: For any dispatch instructions or activities initiated by either the CAISO or PG&E (real events or tests) which prevent the customer from being able to operate under their "normal" conditions during the weekday 12 – 6 timeframe, the participant will receive credits.

- Capacity Incentives: Customers earn an incentive payment per KW of capacity provided.

|  | May | June | July | August | September | October |
|---|---|---|---|---|---|---|
| ($/kW) | $5.00 | $10.00 | $20.00 | $20.00 | $20.00 | $5.00 |

# Next Steps

- January - February: Continue customer recruitment

- March – April: Implementation of equipment/strategies for customers that have enrolled

- May – October: Field study period

- November – December: Paper study and submission to CPUC

# Questions

**John Hernandez (PG&E)**

Sr. Program Manager – IDSM Products

J6H6@pge.com

# IRR Communications Infrastructure

Ed Koch
(ed@akuacom.com)
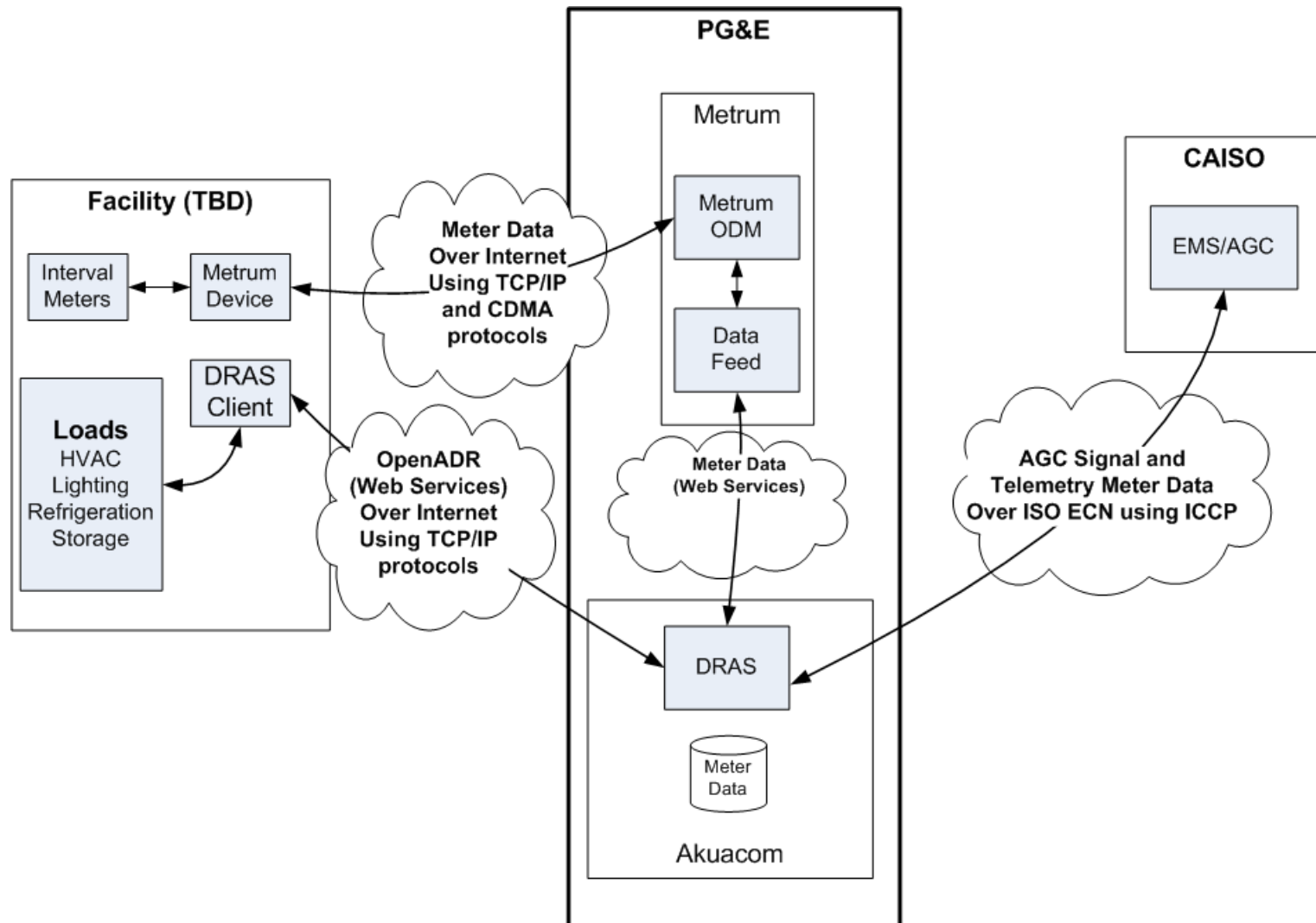415-256-2583
Steve Pierson
(steve@akuacom.com)
Akuacom
(Feb 8, 2011)

# Agenda

- Architecture
- OpenADR Signal Specifications
- DRAS Client Interaction Specifications
- DRAS Client Development Support and Procedures
- Facility Manager Dashboard
- DRAS Client Development Tool Demo

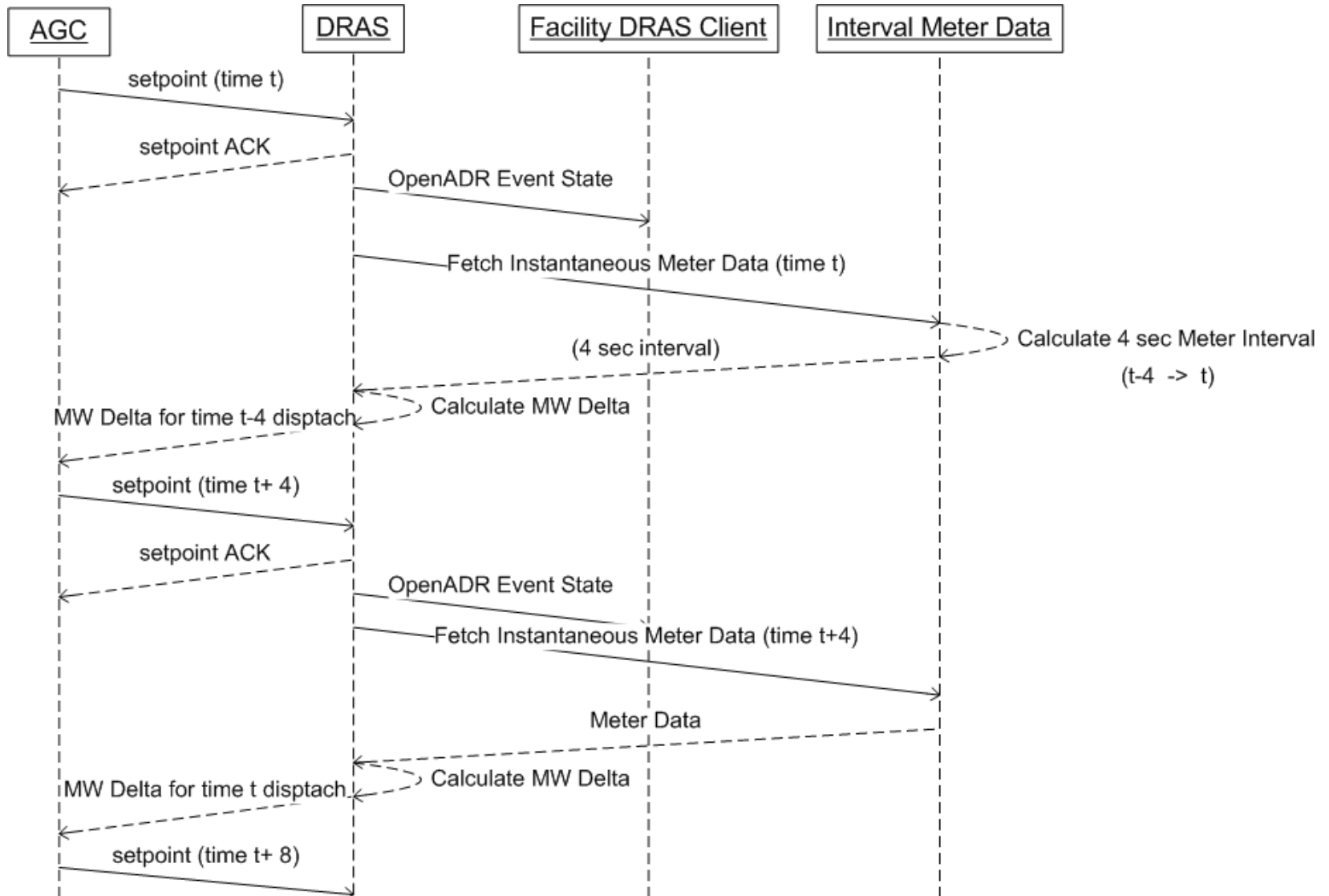# ARCHITECTURE

# Overall Architecture



IRR Technical Demonstration Architecture

# Key Requirements

- Dispatch frequency as little as 4 seconds
- Low latency response
- Fast turn around on telemetry with low latency

# Dispatch Sequence Diagram

# OPENADR SIGNAL SPECIFICATIONS

# OpenADR Event State Attributes

- One DR event per day covering the entire time period of possible participation
- For no dispatches from the CAISO the LOAD_AMOUNT = 0 and the operation mode set to NORMAL
- For each successive dispatch from the CAISO the existing event will be modified as follows:
  - EventInfo type of LOAD_AMOUNT set equal to CAISO dispatch level
  - *If LOAD_AMOUNT != 0 then operation mode set to HIGH. (this is still under discussion)*
  - eventModNumber incremented for each successive dispatch

# Sample Event State XML (No-Dispatch)

- <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
- <p:listOfEventState xsi:schemaLocation="http://openadr.lbl.gov/src/1/EventState.xsd" xmlns:p="http://www.openadr.org/DRAS/EventState" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
-    <p:eventStates offLine="false" testEvent="false" drasName="Akuacom 5.0" schemaVersion="1.0" eventStateID="2134284705" drasClientID="Pierson.BuenaVista" eventIdentifier="110202-155540" eventModNumber="0" programName="CAISO IRR">
-     <p:simpleDRModeData>
-      <p:EventStatus>ACTIVE</p:EventStatus>
-      <p:OperationModeValue>NORMAL</p:OperationModeValue>
-      <p:currentTime>135.0</p:currentTime>
-      <p:operationModeSchedule>
-       <p:modeSlot>
-        <p:OperationModeValue>NORMAL</p:OperationModeValue>
-        <p:modeTimeSlot>0</p:modeTimeSlot>
-       </p:modeSlot>
-      </p:operationModeSchedule>
-     </p:simpleDRModeData>
-     <p:drEventData>
-      <p:notificationTime>2011-02-02T08:00:00.000-08:00</p:notificationTime>
-      <p:startTime>2011-02-02T00:00:00.000-08:00</p:startTime>
-      <p:endTime>2011-02-02T23:59:59.000-08:00</p:endTime>
-      <p:eventInfoInstances>
-       <p:eventInfoTypeID>LOAD_AMOUNT</p:eventInfoTypeID>
-       <p:eventInfoName>setpoint</p:eventInfoName>
-       <p:eventInfoValues>
-        <p:value>0.0</p:value>
-        <p:timeOffset>135</p:timeOffset>
-       </p:eventInfoValues>
-      </p:eventInfoInstances>
-     </p:drEventData>
-     <p:customData/>
-    </p:eventStates>
- </p:listOfEventState>

# Sample Event State XML (Dispatch)

- <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
- <p:listOfEventState xsi:schemaLocation="http://openadr.lbl.gov/src/1/EventState.xsd" xmlns:p="http://www.openadr.org/DRAS/EventState" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
-   <p:eventStates offLine="false" testEvent="false" drasName="Akuacom 5.0" schemaVersion="1.0" eventStateID="2134284705" drasClientID="Pierson.BuenaVista" eventIdentifier="110202-155540" eventModNumber="1" programName="CAISO IRR">
-     <p:simpleDRModeData>
-       <p:EventStatus>ACTIVE</p:EventStatus>
-       <p:OperationModeValue>HIGH</p:OperationModeValue>
-       <p:currentTime>140.0</p:currentTime>
-       <p:operationModeSchedule>
-         <p:modeSlot>
-           <p:OperationModeValue>HIGH</p:OperationModeValue>
-           <p:modeTimeSlot>0</p:modeTimeSlot>
-         </p:modeSlot>
-       </p:operationModeSchedule>
-     </p:simpleDRModeData>
-     <p:drEventData>
-       <p:notificationTime>2011-02-02T08:00:00.000-08:00</p:notificationTime>
-       <p:startTime>2011-02-02T00:00:00.000-08:00</p:startTime>
-       <p:endTime>2011-02-02T23:59:59.000-08:00</p:endTime>
-       <p:eventInfoInstances>
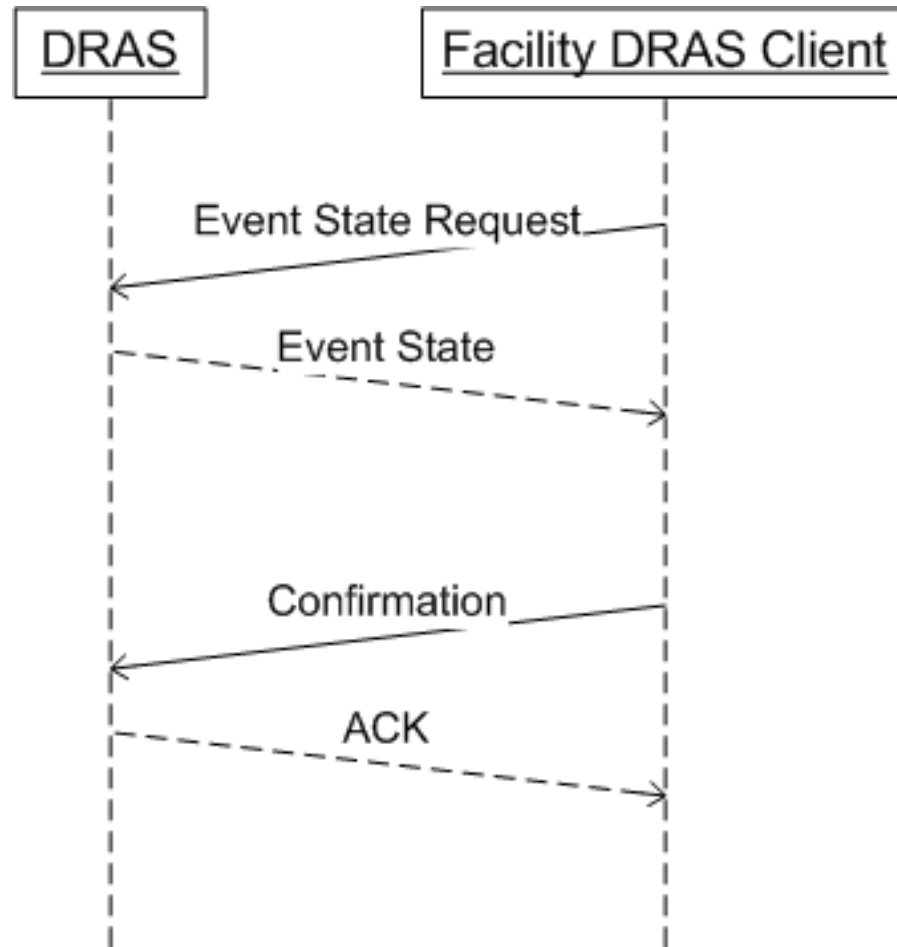-         <p:eventInfoTypeID>LOAD_AMOUNT</p:eventInfoTypeID>
-         <p:eventInfoName>setpoint</p:eventInfoName>
-         <p:eventInfoValues>
-           <p:value>3562.99</p:value>
-           <p:timeOffset>135</p:timeOffset>
-         </p:eventInfoValues>
-       </p:eventInfoInstances>
-     </p:drEventData>
-     <p:customData/>
-   </p:eventStates>
- </p:listOfEventState>

eventModNumber

HIGH mode

Dispatch Level

# DRAS CLIENT INTERACTION SPECIFICATIONS

# General Specifications

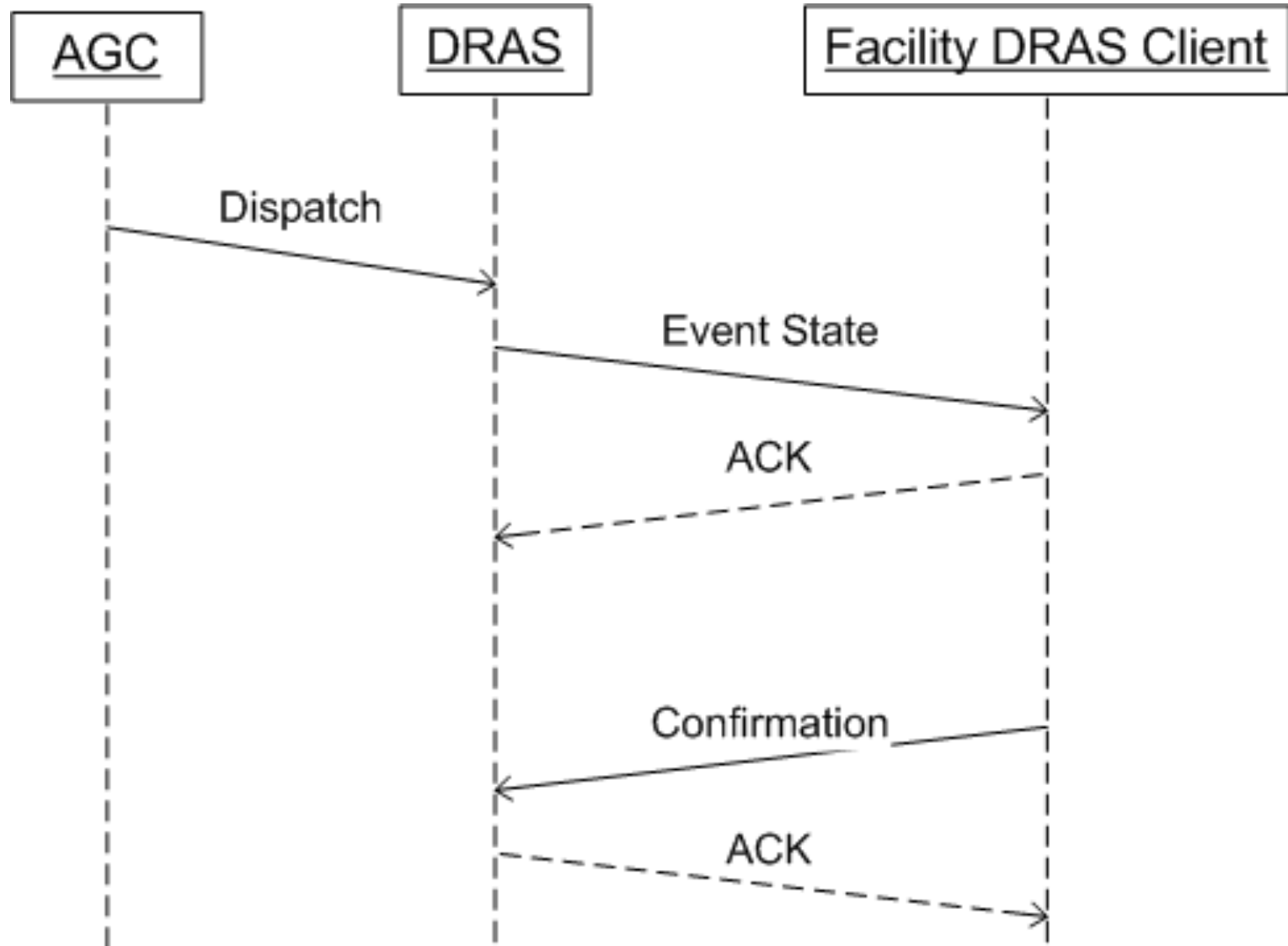- Both PUSH and PULL interactions will be supported.
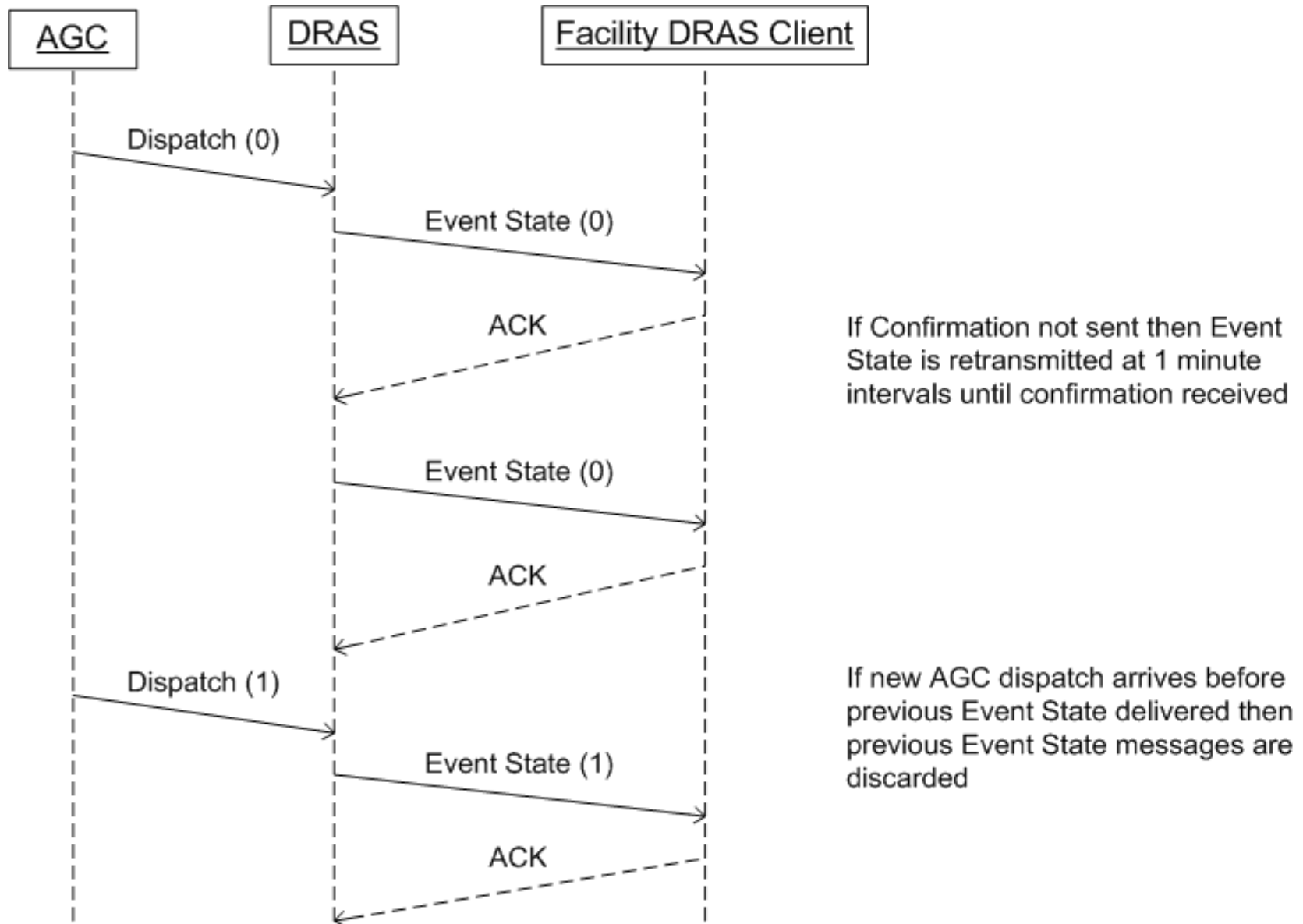
# General PULL Interactions

# PULL Specifications

- PULL can be used to refresh the Event State information in the Client and track the online/offline status of the Client in the DRAS.

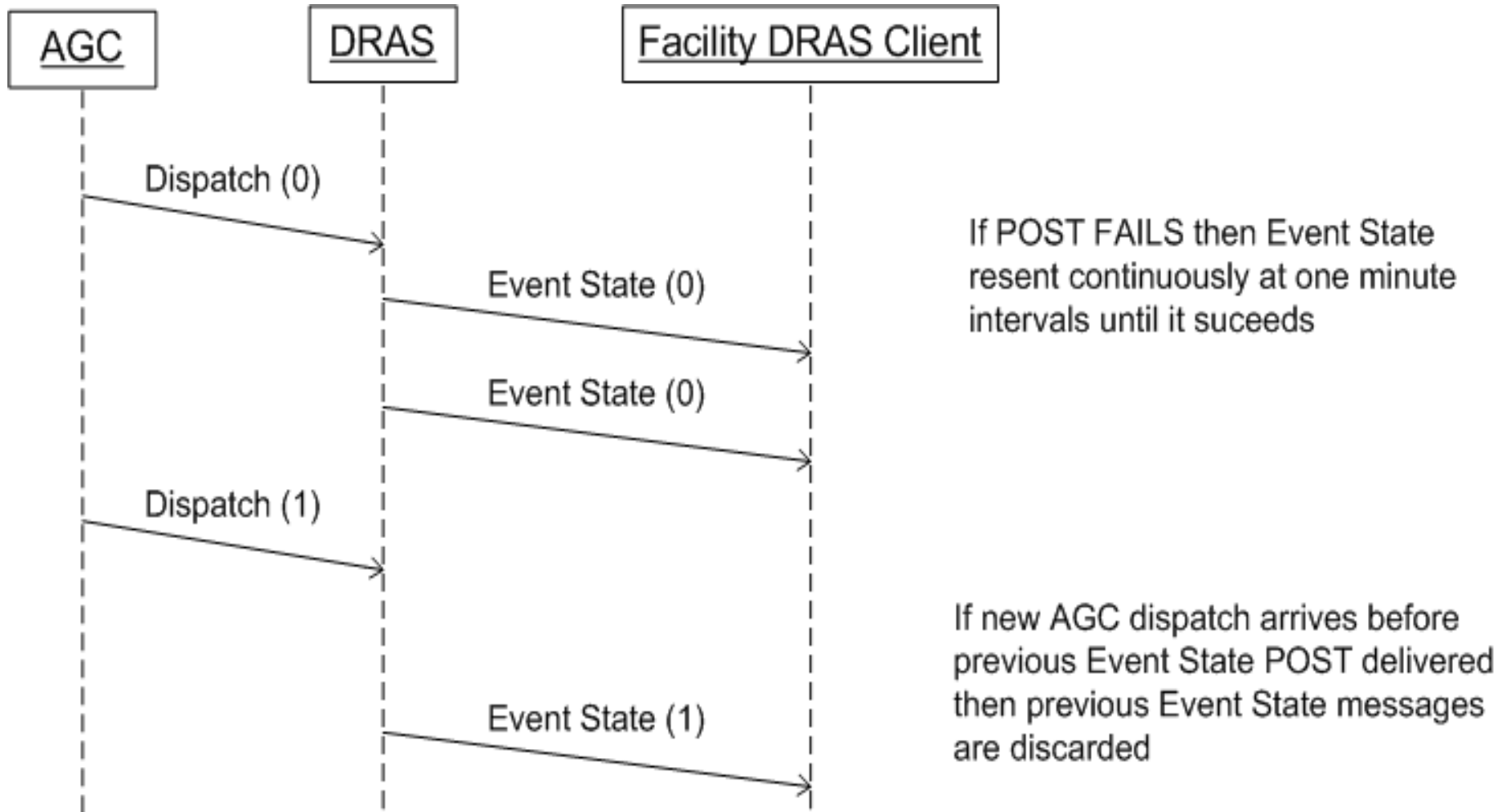- Can poll at a relatively low frequency, but should not poll any more frequent than once per minute.

# PUSH Interaction with Confirmation

# PUSH Interaction w/o Confirmation



AGC | DRAS | Facility DRAS Client

Dispatch (0)

Event State (0)

ACK

If Confirmation not sent then Event State is retransmitted at 1 minute intervals until confirmation received

Event State (0)

ACK

Dispatch (1)

Event State (1)

If new AGC dispatch arrives before previous Event State delivered then previous Event State messages are discarded

ACK

# Failed PUSH Interaction

# PUSH Specifications

- Push messages only sent when dispatch occurs from CAISO and results in an HTTP(S) POST from the DRAS to the Client.
- Need to open hole in firewall to allow access to DRAS Client at the designated IP address and the standard port 80 for unsecured connections and port 443 for secured connections
- Confirmation may be optional, but not sending one will result in the Event State being retransmitted approximately once per minute
- Clients should track event mod numbers to insure they are processing only the most recent dispatches

# Security

- SSL Based

- For the PULL model the DRAS supplies a public certificate and the Client provides a user name/password that is verified.

- Likewise for the PUSH model the Client provides a public certificate and the DRAS will provide a username/password that should be verified by the Client

# DRAS CLIENT DEVELOPMENT SUPPORT AND PROCEDURES

# Development Scenario
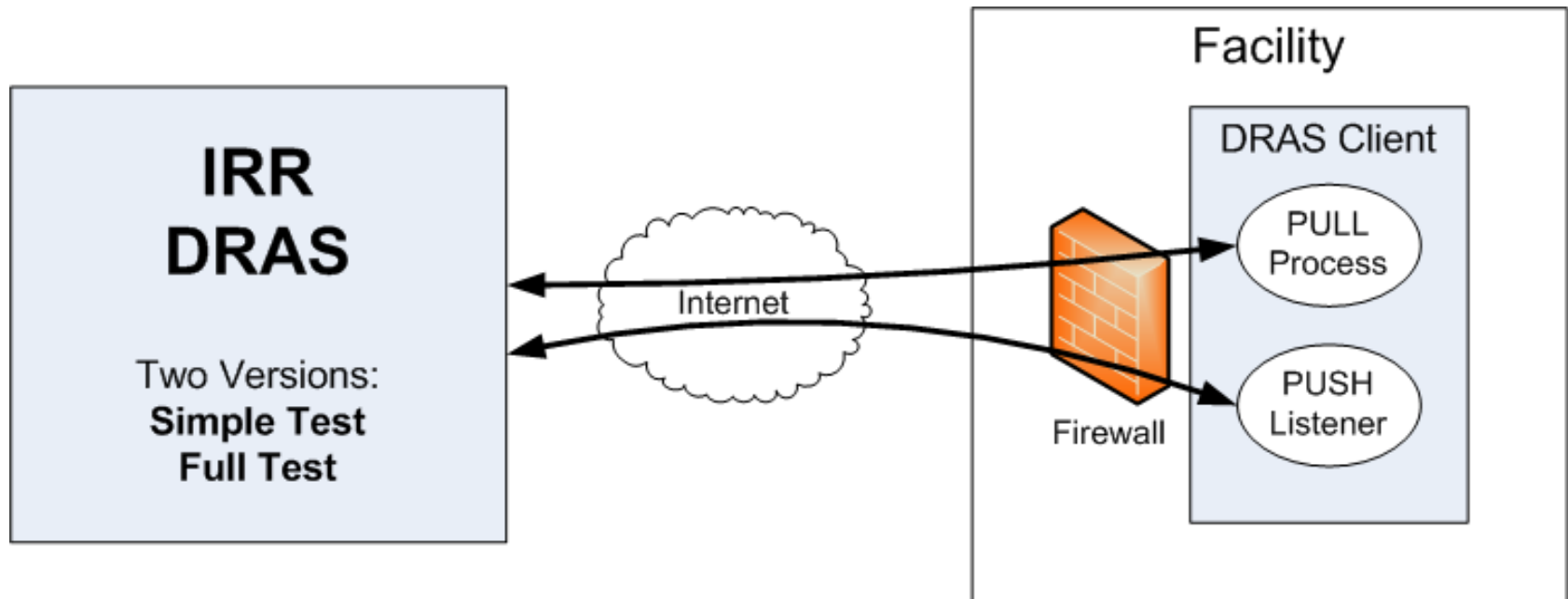
# Development/Testing Steps

1. Perform simple tests using the **Simple Test** DRAS in the lab

2. Perform full tests using the **Full Test** DRAS in the lab

3. Deploy equipment and test shed strategies and control with simulated signals

4. Perform end to end tests including AGC signals

# Simple Test DRAS Features

- Sends out predefined simulated dispatch signals once per minute
    - LOAD_AMOUNT number will vary
    - Operation mode value will change between NORMAL and HIGH
- PULL interactions work
- Confirmation and retry mechanisms not supported
- Used to test communications infrastructure including firewall and security issues
- Allows for the development and testing of Event State XML parsing

# Client Development Process Using the Simple Test DRAS

1. Obtain example code and docs from Akuacom
   – PUSH Listener example code and docs
   – PULL Client example code and docs (existing Client Developer Program docs)
2. Establish account on the DRAS
3. Run PUSH Listener example code in unsecured fashion. This will test for any firewall and environment issues
4. Run PUSH Listener example code in secured fashion. This will test security configurations
5. Implement own PUSH Listener and consume XML
6. If necessary implement PULL Client and test against DRAS

# Full Test DRAS Features

- Fully functional interactions including retry and confirmation support

- Participant UI for generating and sending your own dispatches

# Client Development Process Using the Full Test DRAS

1. Obtain Participant account on the DRAS

2. Use the demo program UI similar to the existing Client Developer Program to issue yourself event

3. Deploy system to facility and test shed strategies by issuing events and monitoring usage

Note: This Dashboard is subject to change, depending upon which version is released with the final Server used for the IRR project.

# FACILITY MANAGER DASHBOARD

# Example Facility Dashboard
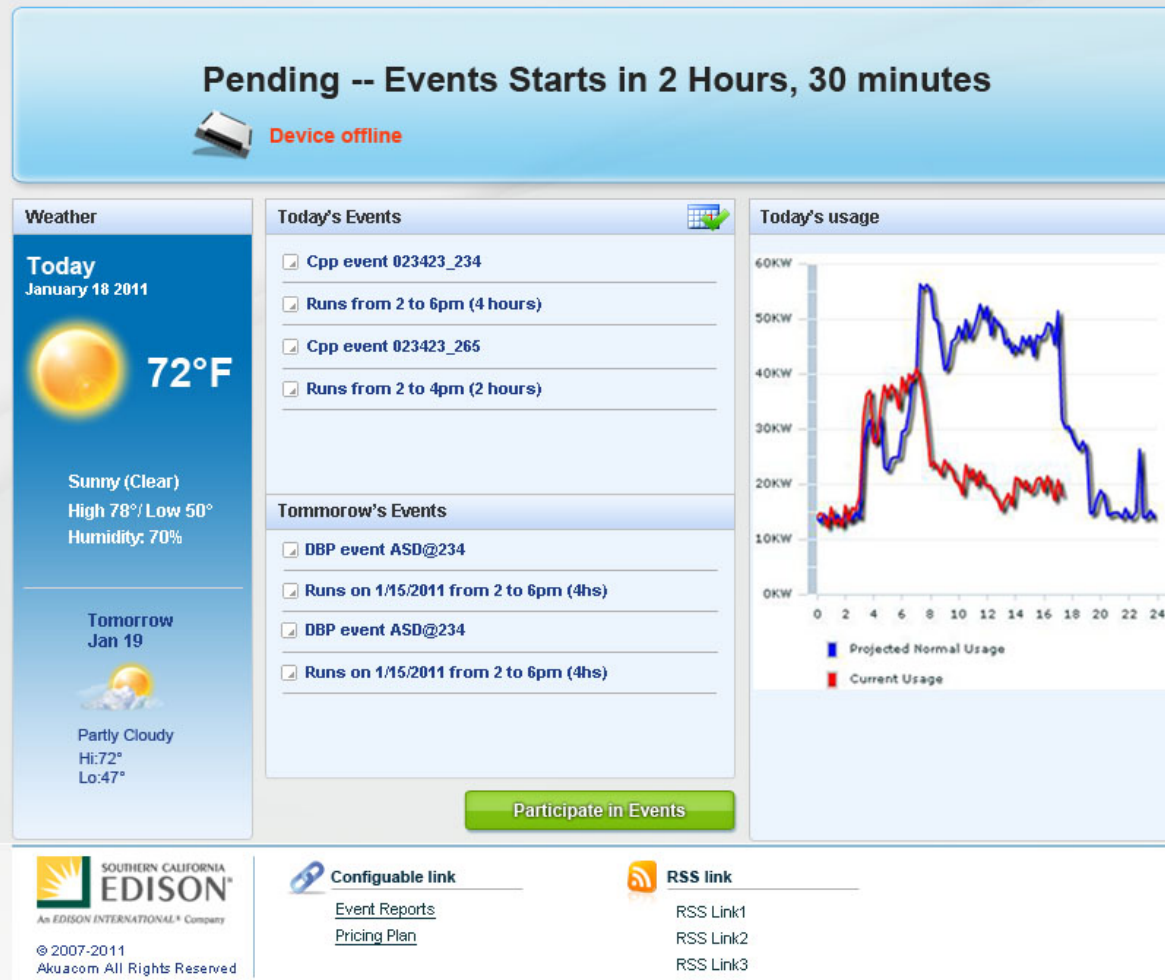
# DRAS CLIENT DEVELOPMENT TOOL DEMO

# Demand Response as a Resource for Managing Intermittency of Renewable Generation

**February 8, 2011**

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**skiliccote@lbl.gov**
**510.384.1635**

**Demand Response Research Center**
**Building Technologies Dept.**
**Environmental Energy Technologies Division**
**Lawrence Berkeley National Laboratory**

**drrc.lbl.gov**

# Presentation Overview

- What does it mean to participate in CAISO's Ancillary Services Market?

- How can a facility respond to Regulation Up/ Regulation Down

- What is the process for enablement?

- Timeline

# Demand Side Management and Automated DR Future

**Increasing Interactions with Grid (OpenADR & Smart Grid)**



**Service Levels Optimized**    **Time of Use Optimized**    **Service Levels Temporarily Reduced**

**Increasing Levels of Granularity of Control**
**Increasing Speed of Telemetry**
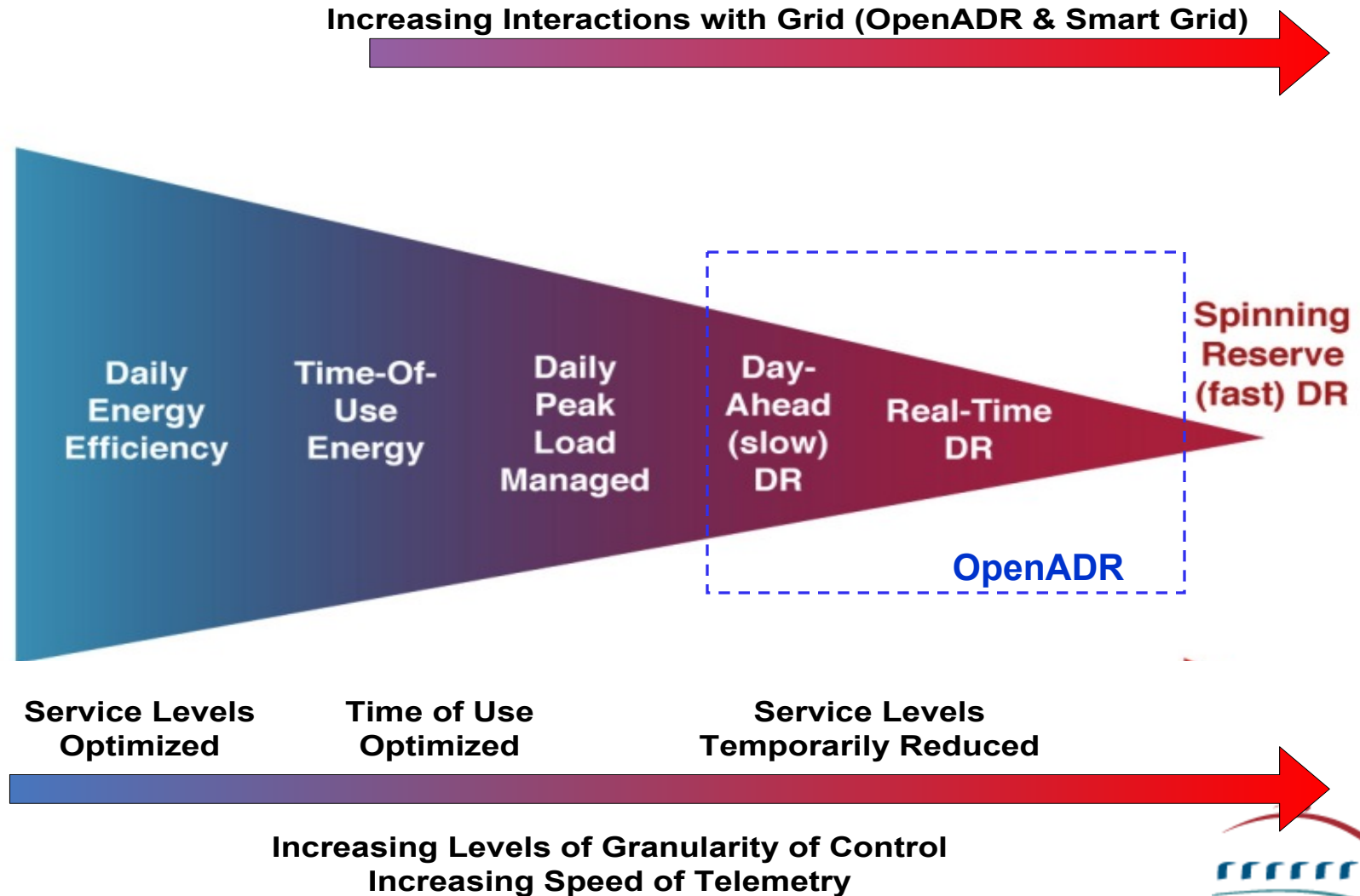
# DR for Integrating Renewable Resources (IRR)

- California's Renewable Portfolio Standards: 33% renewable integration by 2020

- Wind and Solar resources are variable and intermittent

- Challenges:

  - Intra-hour variability

  - Ramping

  - Forecast error

  - Over generation

Goal: Identify communications needs and develop strategies in C&I facilities and test these to address the renewable integration challenges.

# CAISO Ancillary Services Market

| AutoDR for Existing CAISO A/S products | Service | Response Time | Duration |
|---|---|---|---|
| **AutoDR** | Regulation Up | Start <1 min.      Reach bid  <10 min. | 15 - 60 min. |
| **AutoDR** | Regulation Down | Start <1 min.      Reach bid  <10 min. | 15 - 60 min. |
| **AutoDR** | Non-Spinning Reserve | < 10 minutes | 30 min. |
| Future (?) | Spinning Reserves | ~ Instant Start      Full Output <10 min. | 30 min. |

# Participating Load Pilot (PLP)
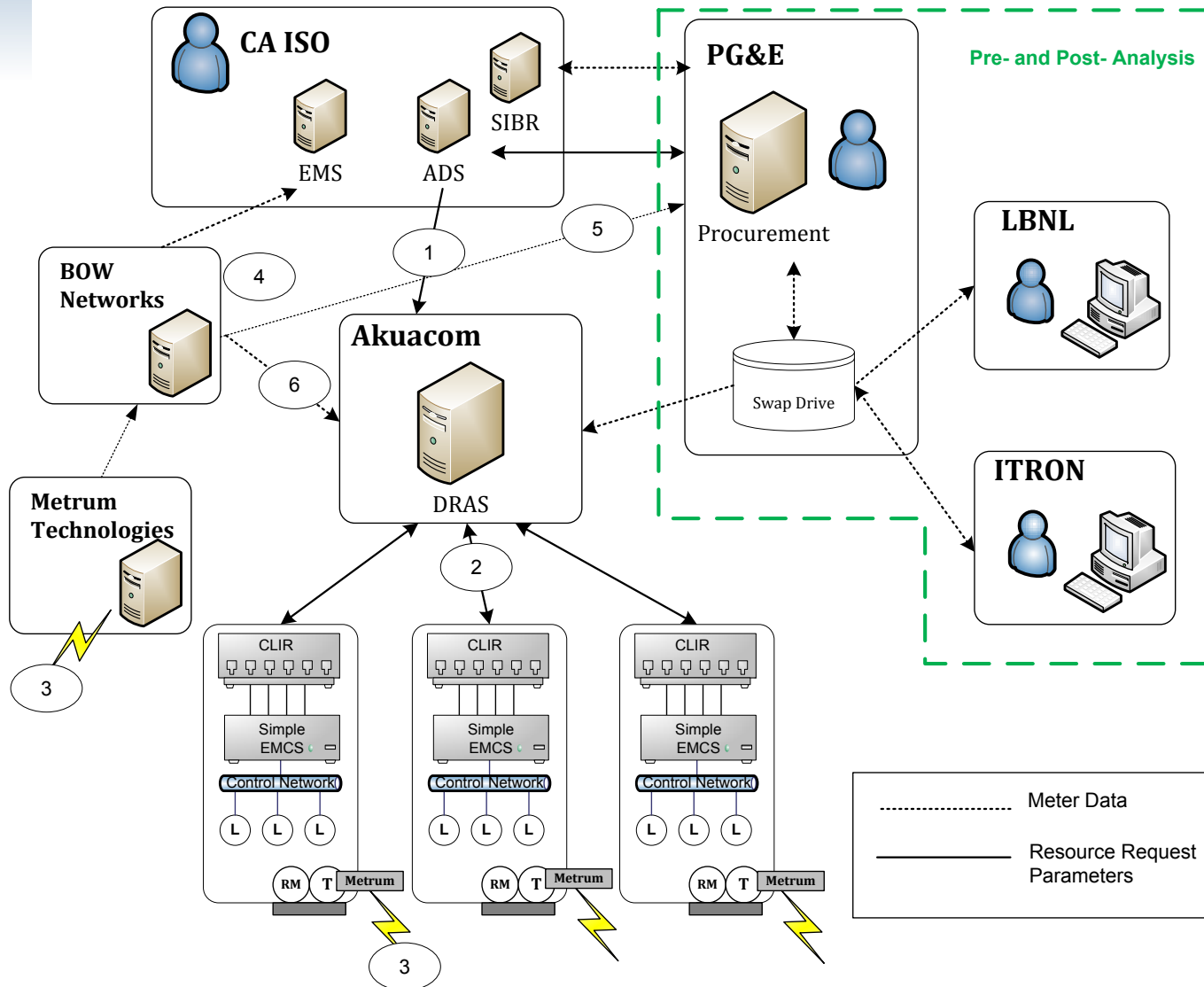


**Acronyms**:

**EMS** – Energy Management System

**ADS** – Automatic Dispatch System

**SIBR** – Scheduling Infrastructure Business Rules

**DRAS** – DR Automation Server

**CLIR** – Client Logic with Integrated Relay

http://newscenter.lbl.gov/feature-stories/2009/08/19/smart-grid-success/

# DR Strategies at Participating Load Pilot Sites

| Site | DR Strategy | DR Period |
|------|-------------|-----------|
| **IKEA EPA** | Turning off 11 RTUs out of 43 and raising zone setpoints to 76 DegF | Noon to 6 pm |
| **Contra Costa County** | 4 DegF Global Temperature Adjustment with 1 DegF increments | 2 pm to 6 pm |
| **Svenhards** | Turn off Pan Washer | 3 pm to 5 pm |

# Contra Costa County Building -

# Load regarded as Pseudo Generation
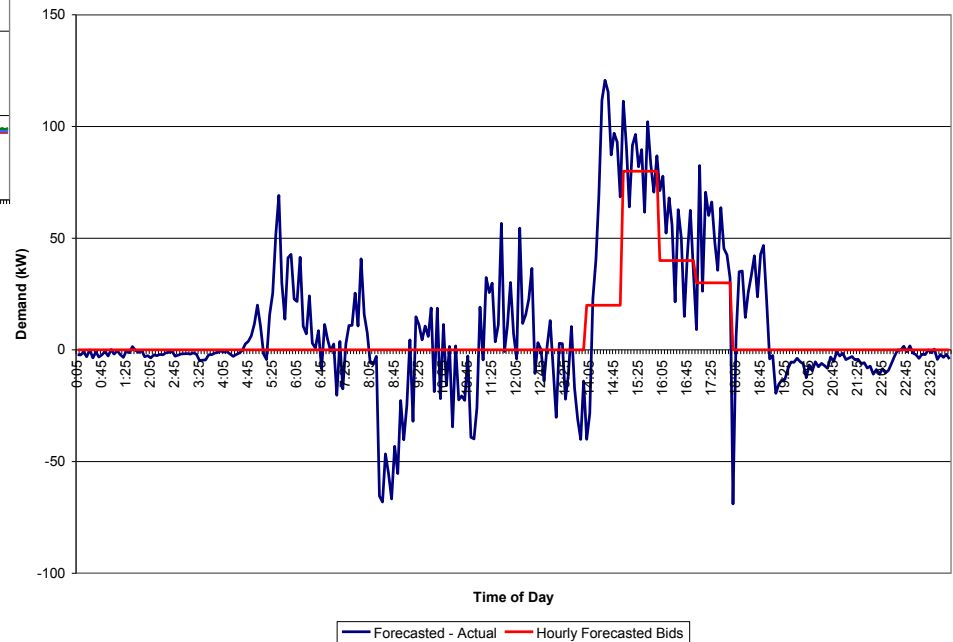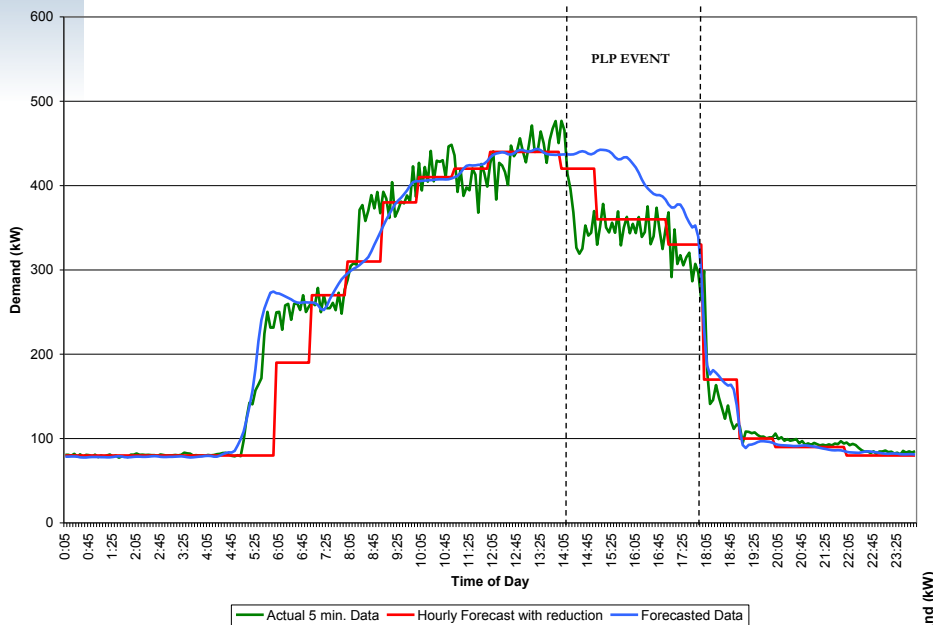


**Pseudo Generation = Forecasted – Actual Demand**

# What we learned from the Participating Load Pilot

- HVAC as an end use and global temperature adjustment as a DR strategy meet the requirements for wholesale ancillary services.

- OpenADR specification is used to communicate wholesale DR events in an open and interoperable way.

  – Customer's transition from Auto-DR programs to PLP is seamless

- Internet can be used for fast DR to dispatch non-spinning ancillary services.

- Pseudo Generation is how DR resources are represented as generation.

# Challenges with using load for Regulation Up and Regulation Down Products

- **Communication challenges:**
  - **Four second telemetry**
  - **Poll vs. Push**
  - **Close-loop vs. Open-Loop**

- **Demand Side issues:**
  - *Which end-use, How long, how often, how much?*
  - *How to represent DR as pseudo generator*

- **Integration issues**
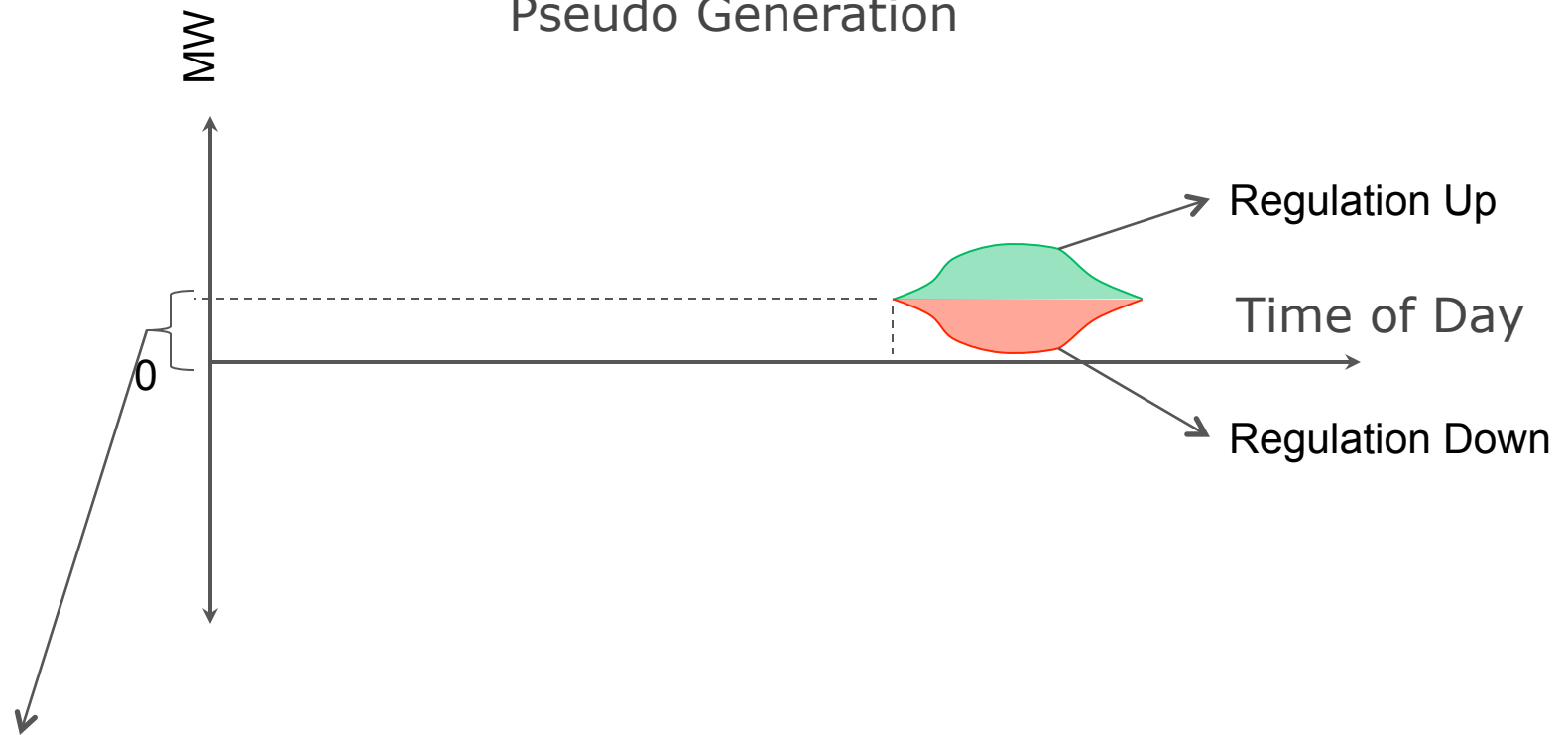  - *How can CAISO instruct a DR resource?*
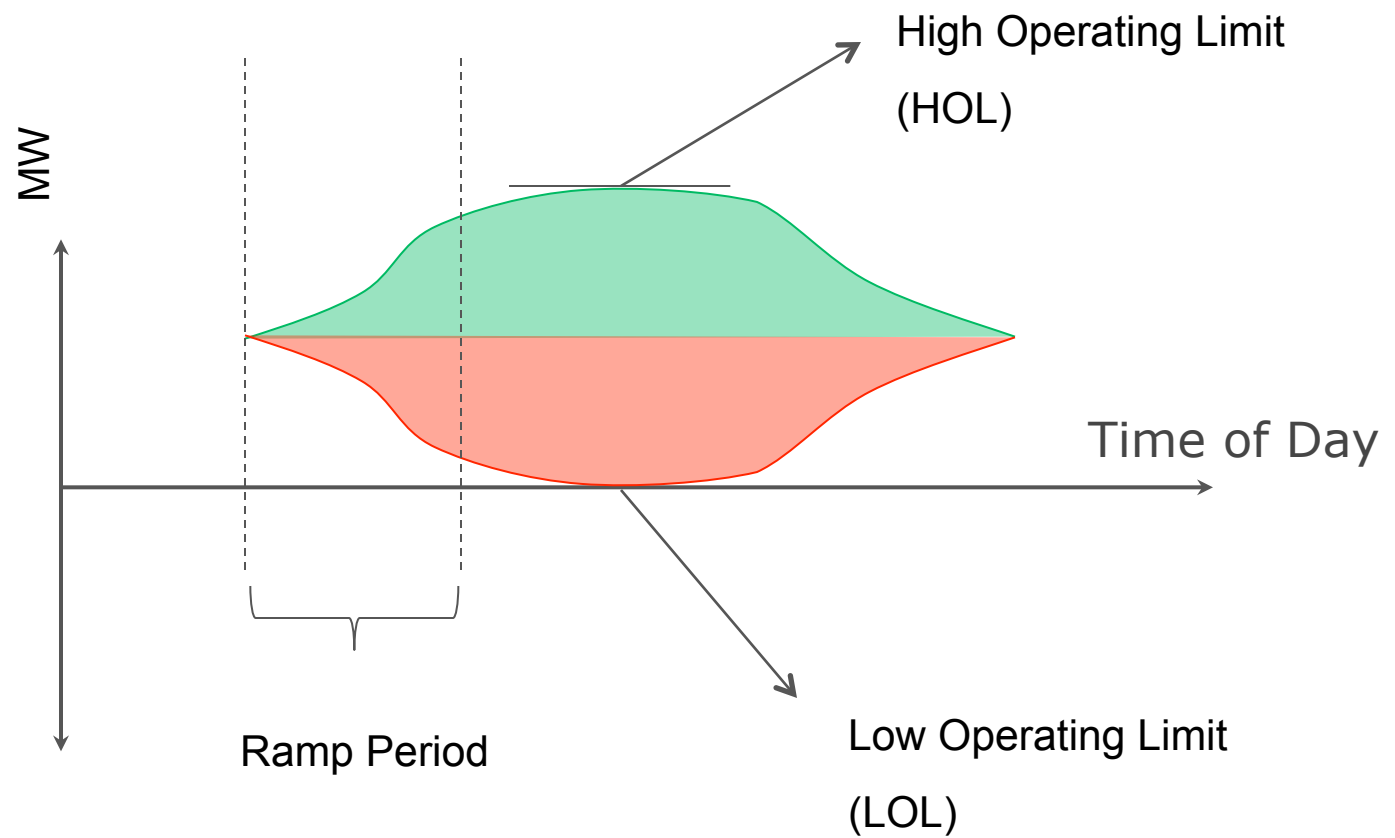
58
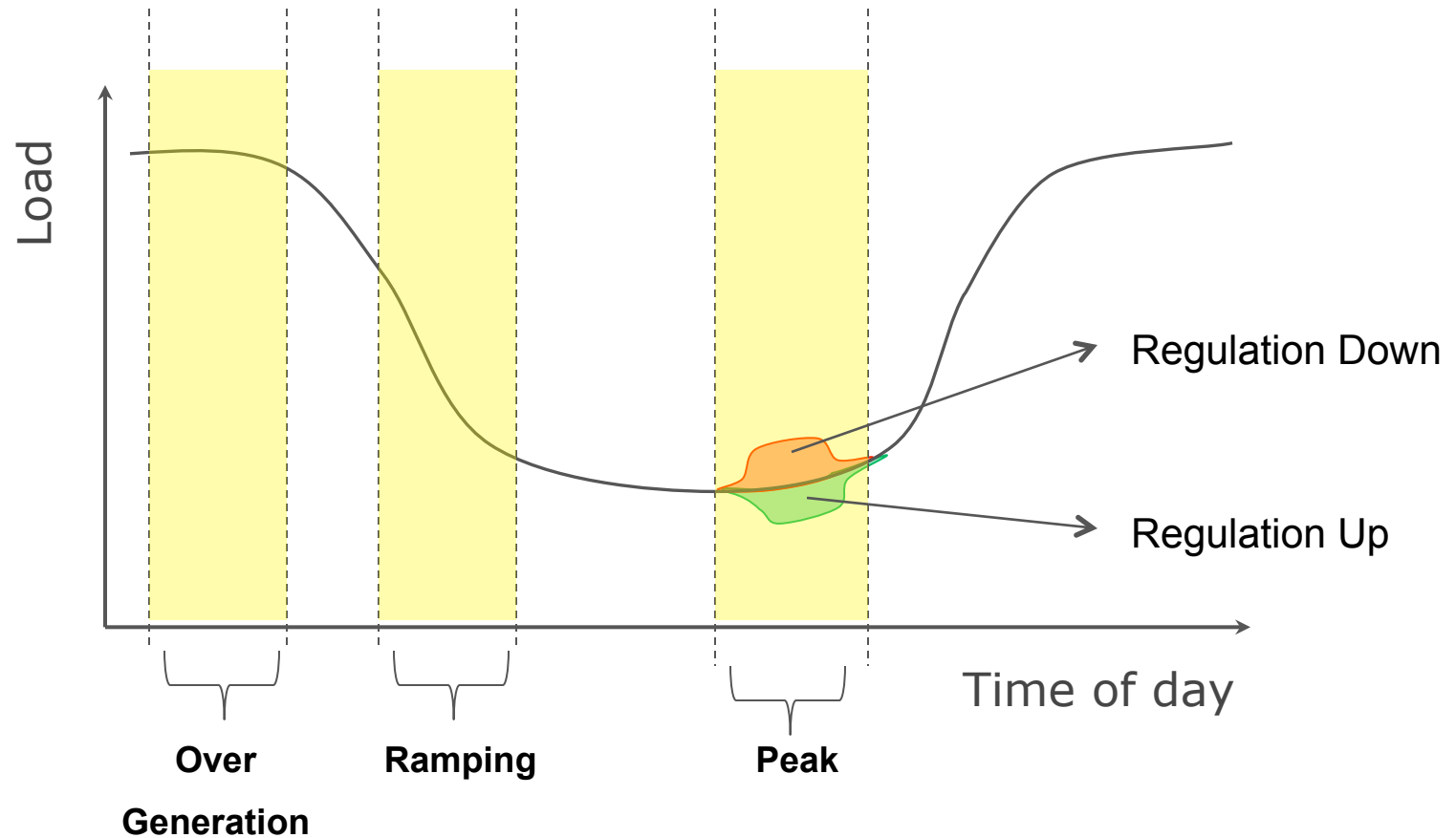
# Pseudo Generation For
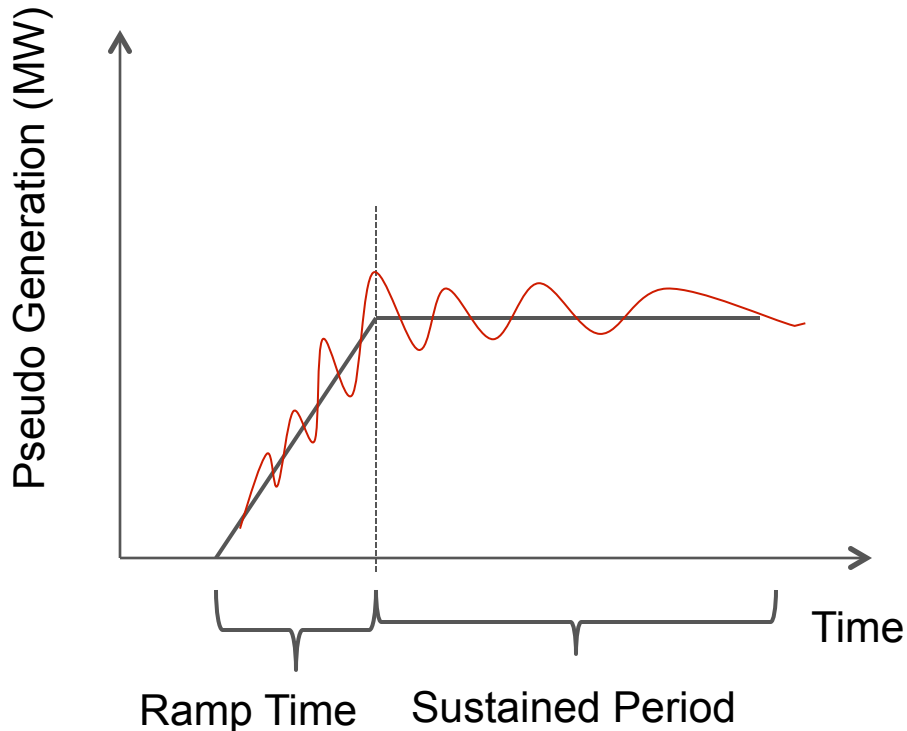# Regulation Up and Regulation Down

Pseudo Generation

MW

Regulation Up

Time of Day

0
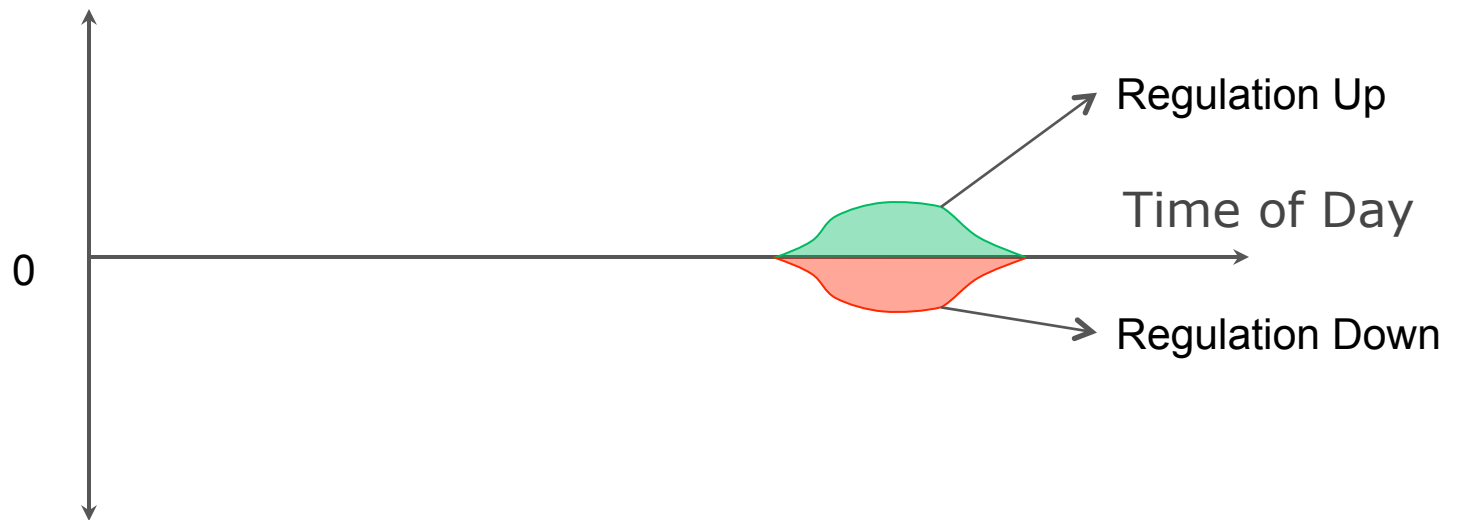
Regulation Down

Offset = Max Regulation Down

High Operating Limit (HOL)

MW

Time of Day

Ramp Period

Low Operating Limit (LOL)

# Why 4 Second Telemetry



For each resource, CAISO requests the following:

-Ramp Rate (MW/s)

-High operating Limit

-Low Operating Limit

When CAISO instructs a set point to a resource, 4 sec. telemetry is used to make sure the resources is following its projected ramp rate and operating limits
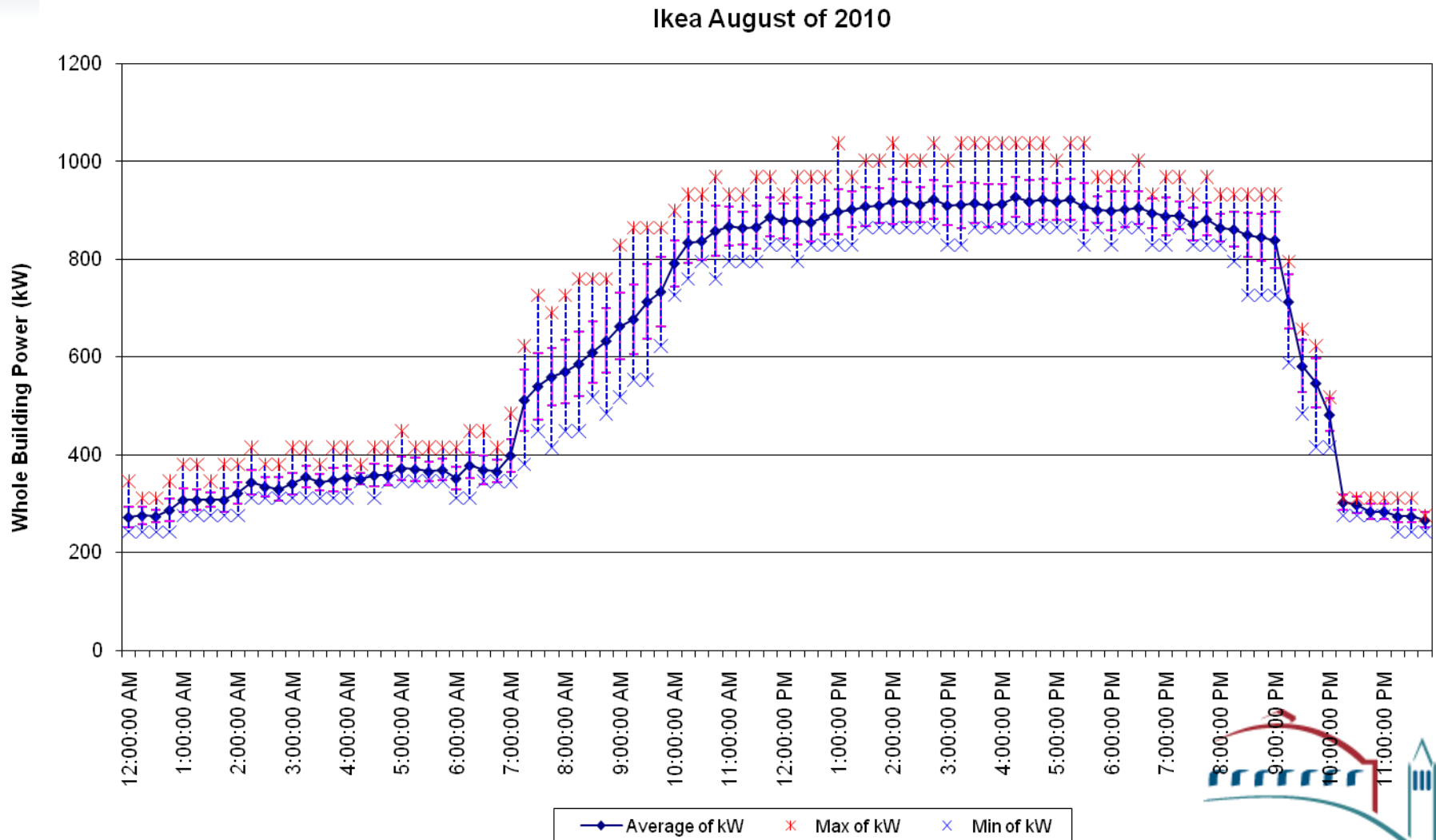
LSS a plot of average, minimum and maximum points for a given range of dates.

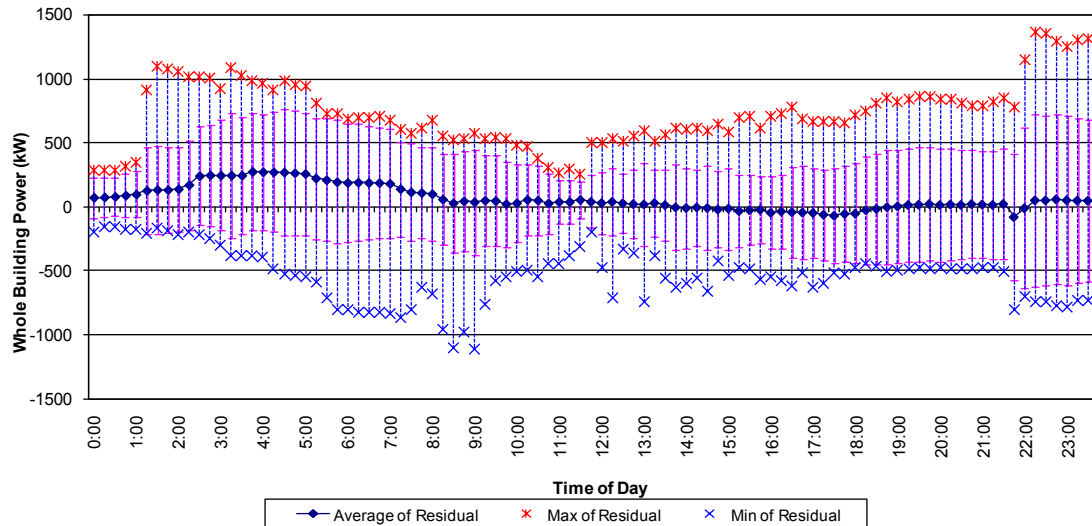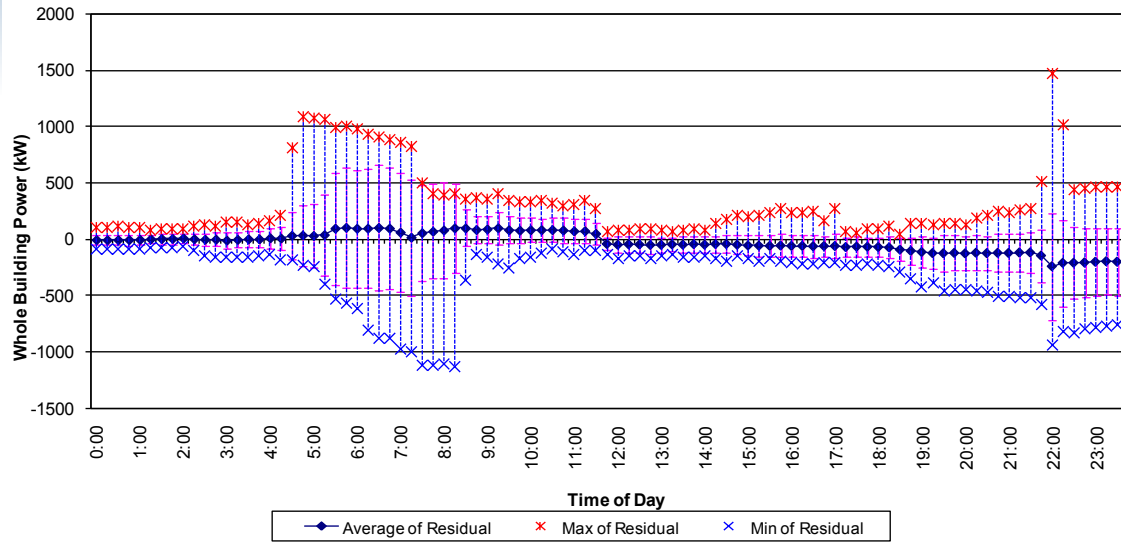 - Refined to display Near-base load and near-high load (2.5 and 97.5 percentile values) (Price 2010)

# Sample LSS



Ikea August of 2010

65
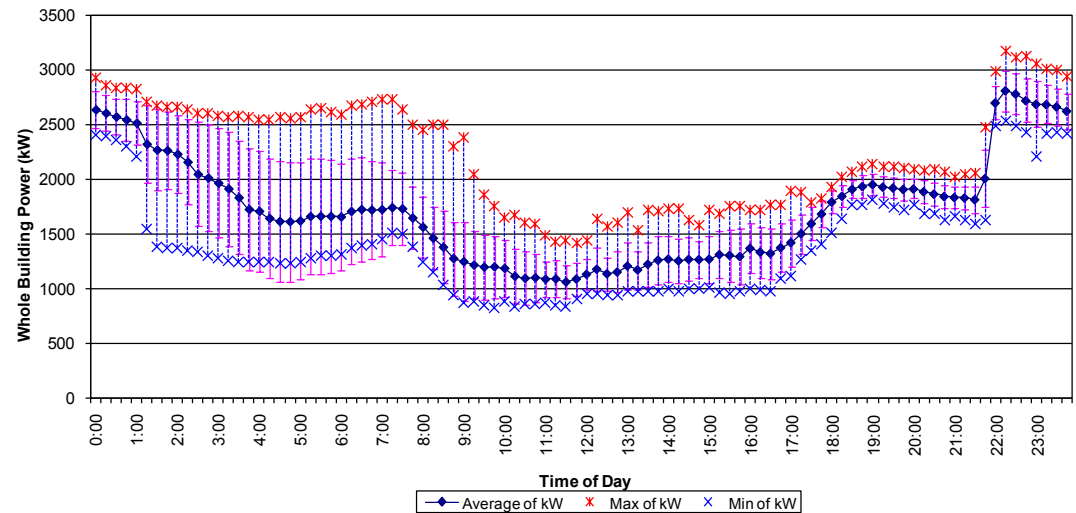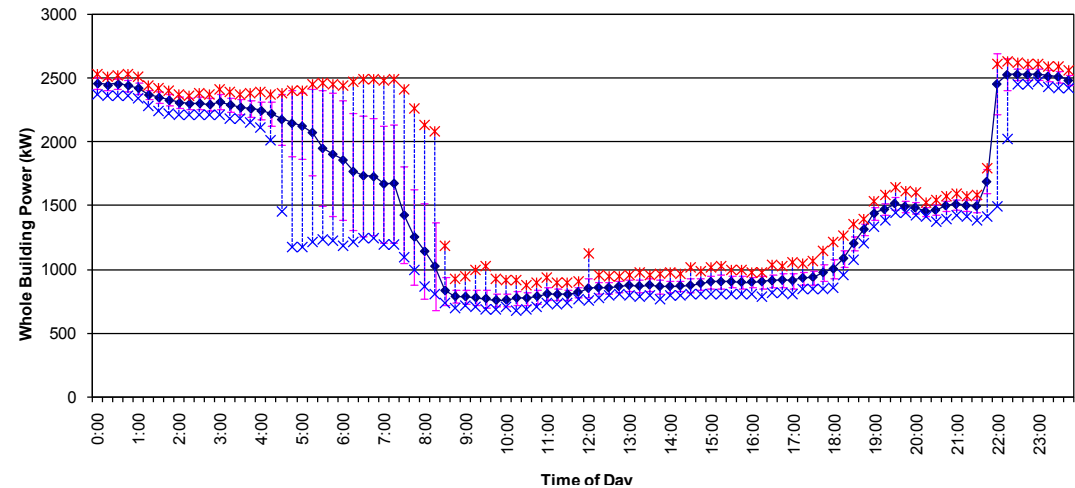
# Pseudo Generation Graphs with LSS

# End Uses & Response

| End Use | Type | Ramp Down | Switching Off |
|---------|------|-----------|---------------|
| HVAC | Chiller Systems | Setpoint Adj. | |
| | Package Unit | Setpoint Adj. | Disable Compressors |
| Lighting | Dimmable | Reduce Level | |
| | On/Off | | Bi-Level Off |
| Refrig/ FrozenWareh ouse | | Setpoint Adj. | |
| Data Centers | | Setpoint Adj., Reduce CPU Processing | |
| Ag. Pumping | | | Turn Off selected pumps |
| Wastewater | | | Turn Off selected pumps |
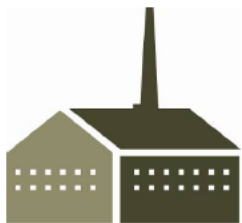
# Enablement Process

- Memorandum of Understanding (MOU) between Facility and Lawrence Berkeley National Laboratory

- Schedule meetings for enablement (controls vendors, LBNL, Akuacom and facilities)

    - Control Strategies

    - Communication Infrastructure

    - Telemetry Installation

- Communication and Control Test

# Pilot Timeline

- February – Recruitment and Enablement

- March – Enablement

- April – Communication and Control Tests

- May through October – Field Tests

- November – Data analysis and report development

- December – Final Report

# THANK YOU!

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